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Research Article

PLC Based Automatic Cooling of Power Transformer

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ABSTRACT
This project deals with the monitoring and control of cooling system of a transformer using automation. Probability of faults on power transformer is undoubtedly more and hence automatic protection is absolutely necessary. Temperature sensor is used to sense the temperature of the power transformer that provides the value of temperature. Output from the sensor is fed to the Programmable Logic Controller (PLC). A PLC is a digitally operating system designed for use in an industrial environment, which uses a programmable memory for its internal operation of user-oriented instructions and for implementing specific function such as logic, sequencing, timing, counting and arithmetic. By introducing PLC into action the process becomes more flexible, reliable and PC friendly. HMI activities are availed to have better visualization of the process and control. Trouble shooting experience becomes easier now compared to existing technology.

INTRODUCTION

Transformer is a static device used for transforming power from one circuit to another without changing the frequency. A transformer consists of two insulated windings interlinked by a common or mutual magnetic field established in a core of magnetic material. Primary winding is connected to alternating voltage source which produces mutual flux in the secondary due to electromagnetic induction. EMF induced in the secondary is same as the primary of same frequency with different magnitude. When the number of primary and secondary turns are proportional, almost any desirable voltage ratios can be obtained by tapping the transformer. The construction should ensure efficient removal of heat from the winding, so that the temperature rise is limited. In the power system the transformer is used to step up or step down the generating voltage. During operation the winding of the power transformer gets heated up, leading to power loss. Due to the long lead time for repair of transformers, main objective is to limit the damage to the faulted transformer. Some protection purpose such as over excitation protection and temperature protection may help by identifying operating condition that can cause transformer failure.

Literature Survey

Traditionally the transformer cooling system is controlled via contactors, intermediate relays, timer relays, temperature relays etc.

Block Diagram

The three phase power supply is given to the isolation transformer. The main purpose of the isolation transformer is to prevent the device from any fault. In this diagram isolation transformer is used to convert the three phase supply into single phase supply from the secondary tapings of the transformer. The tapped output of the isolation transformer is connected to the bus bar. From the bus bar, a single phase supply, 230V is connected to the PLC input. The Switched Mode Power Supply (SMPS) is used to convert 230V alternating current into 24V direct current. The converted DC supply is fed to the PLC input as sink/source. Programmable Logic Controller (PLC). A PLC is a digitally operating system designed for use in an industrial environment, which uses a programmable memory for its internal operation of user-oriented instructions and for implementing specific function such as logic, sequencing, timing, counting and arithmetic. By introducing PLC into action the process becomes more flexible, reliable and PC friendly. HMI activities are availed to have better visualization of the process and control. The PLC used in this project has 6 inputs and 4 outputs. The input of the PLC are push buttons and sensor. Here, push buttons are used for manual switching and sensor is used as an automatic switching of cooling system. Temperature sensor is used sense the temperature of the power transformer. The output of the PLC is given to different transformer

cooling system. The PLC is programed using ladder logic. The transformer cooling types are fan cooling, oil cooling and both fan and oil cooling surrounding the transformer for control of oil and winding temperature. These equipment are operated at oil temperature 65^0C, 75^0C, 85^0C respectively. The PLC is already programmed to operate automatically when this temperature is reached. When the oil temperature reaches 65^0C, the fan cooling is operated. Similarly, when the temperature reaches 75^0C, the oil cooling is operated and when the oil temperature reaches 85^0C, both fan and oil cooling is operated. In this way the temperature of oil and winding is controlled in the power station.

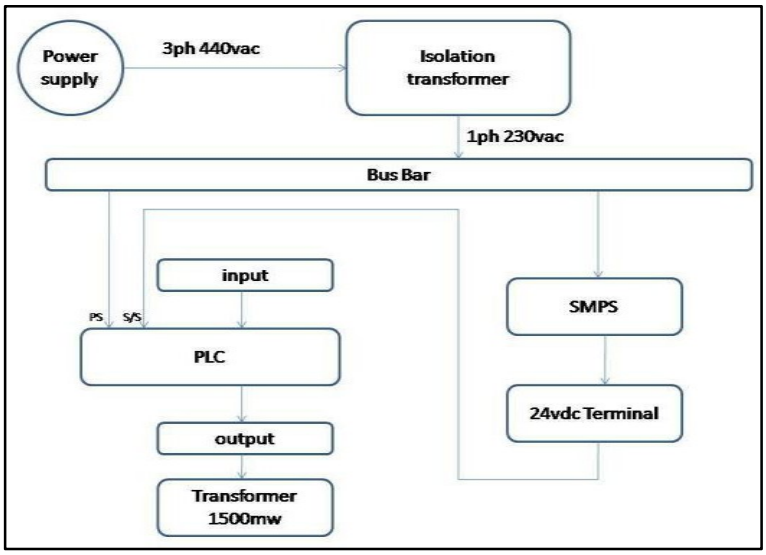
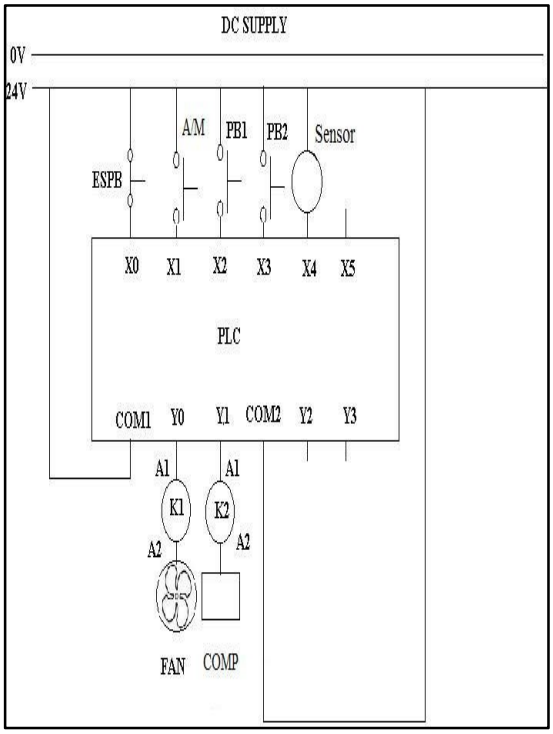


Fig 1 Block Diagram



Circuit Diagram

Fig 2 Circiut Diagram

In the above circuit diagram, PLC is used to automate the transformer cooling system. The PLC has six inputs and four outputs. The inputs are X0, X1, X2, X3, X4 and X5. The input X0 is the Emergency Stop Push Button (ESPB) which is used to disconnect the circuit in case of emergency situation or fault. X1 is the auto or manual mode push button which is used to select the system to operate either in manual mode or automatic mode. The input X2 and X3 are the push button 1 and push button 2 which is used to operate the fan and oil cooling in the manual mode. The X4 is the sensor input which is used to sense the oil and winding temperature of power transformer and to operate the in the automatic mode of operation. The output Y0 and Y1 are the output of PLC fed to the fan and the compressor. When the oil and winding temperature reaches 65^0C, the fan cooling (Y0) is operated. Similarly, when the temperature reaches 75^0C, the oil cooling (Y1) is operated and when the oil temperature reaches 85^0C, both fan and oil cooling (Y0&Y1) is operated. In this way the temperature of oil and winding is controlled in the power station.

Ladder Logic Diagram

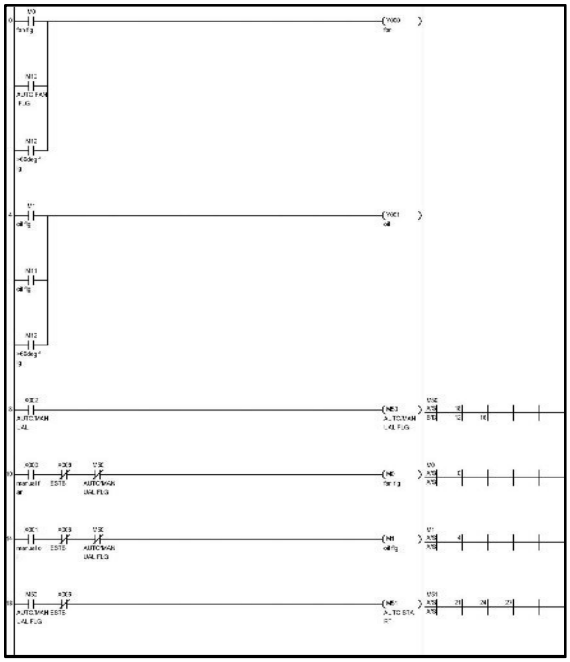


Fig 3 Ladder logic Diagram Working of PLC

A programmable logic controller is a specialized computer used to control machines and processes. It therefore shares common terms with typical PCs like central processing unit, memory, software and communications.

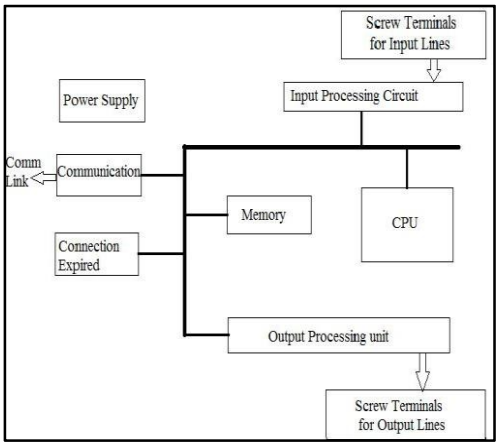
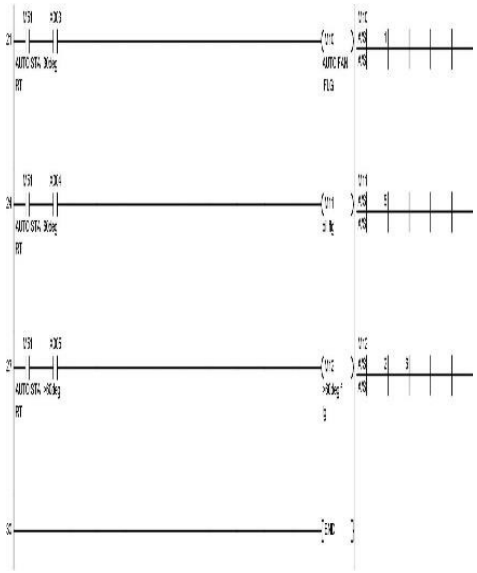


Fig 4 PLC Hardware

checking the PLC controller to avoid errors. They perform functions including logic operations, arithmetic operations, computer interface and many more. Memory – Fixed data is used by the CPU. System (ROM) stores the data permanently for the operating system. RAM stores the information of the status of input and output devices, and the values of timers, counters and other internal device. I/O section – Input keeps a track on field devices which includes sensors, switches. O/P Section - Output has a control over the other devices which includes motors, pumps, lights and solenoids. The I/O ports are based on Reduced Instruction Set Computer (RISC).Power Supply – Certain PLCs have an isolated power supply. But, most of the PLCs work at 220VAC or 24VDC.Programming Device – This device is used to feed the program into the memory of the processor. The program is first fed to the programming device and later it is transmitted to the PLC's memory.

System Buses – Buses are the paths through which the digital signal flows internally of the PLC. The four system buses are: Data bus is used by the CPU to transfer data among different elements. Control bus transfers signals related to the action that are controlled internally. Address bus sends the location's addresses to access the data. System bus helps the I/O port and I/O unit to communicate with each other Inputs Input devices can consist of digital or analog devices. A digital input card handles discrete devices which give a signal that is either on or off such as a pushbutton, limit switch, sensors or selector switches. An analog input card converts a voltage or current (e.g. a signal that can be anywhere from 0 to 20mA) into a digitally equivalent number that can be understood by the CPU. Examples of analog devices are pressure transducers, flow meters and thermocouples for temperature readings.



Outputs

Output devices can also consist of digital or analog types. A digital output card either turns a device on or off such as lights, LEDs, small motors, and relays. An analog output card will convert a digital number sent by the CPU to it's real world voltage or current. Typical outputs signals can range from 0-10 VDC or 4-20mA and are used to drive mass flow controllers,pressure regulators and position controls.

Conculsion

The objective of this project is to monitor and control process based on PLC. Since the power transformer carries high current, monitoring oil temperature and winding is crucial and most required one.

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